REAL-TIME ALERT MECHANISM FOR MONITORING AND CONTROLLING FIELD ASSETS VIA WIRELESS AND INTERNET TECHNOLOGIES

TECHNICAL FIELD

The present invention relates generally to field asset monitoring and control. More particularly, the present invention relates to a system and apparatus for the real-time monitoring and control of field assets using wireless and Internet technologies.

BACKGROUND

Businesses in which the assets responsible for the generation of revenues are dispersed over wide geographic regions have existed for many years. For example, a vending machine operator may have hundreds of vending machines located at schools, office buildings, etc. across a large metropolitan area. Similarly, many oil companies are known to own and operate numerous oil wells located amongst multiple states if not also across multiple continents.

Managing such dispersed field assets generally requires a significant amount of resources. Typically, a technician travels a service route that takes him to each of the vending machines in the vending business operator's network. Such a service method may have the technician returning to a vending machine only once every month. As such, great expenditures of time and money are likely to be incurred in order to effect proper maintenance of each of the field assets.

In addition to the significant resources needed to effectively manage such distributed asset businesses, there also exists a substantial risk for lost revenues. For example, if a field asset becomes disabled shortly after a technician visit, it may be some time before the technician returns to the disabled asset to discover and render the needed repairs. During the down time of the field asset, no revenues can be generated by the disabled asset. Similarly, if a vending machine should deplete its inventory, that vending machine will not be able to generate revenues until a technician returns and restocks the inventory.

SUMMARY OF THE INVENTION

In accordance with teachings of the present invention, a system and apparatus are described for using wireless and Internet technologies for the real-time monitoring and control of field assets.

In one aspect of the present invention, an apparatus for managing a field asset is provided. The apparatus preferably includes memory coupled to at least one processor. The apparatus preferably further includes a communications interface coupled to the processor and the memory that is operable to communicate with a controller board coupled to the field asset. A program of instructions, storable in the memory and executable in the processor, operable to correct one or more error conditions and further operable to package uncorrected error conditions for transmission is also preferably included in the apparatus. A wireless network interface may also be included and is preferably coupled to the memory and the processor. The wireless network interface may be employed to transmit the packaged error conditions to a network operations center via a wireless network.

In yet another aspect of the present invention, a system for the Internet enabled management of a field asset is provided. The system preferably includes a field asset having a controller board operable to detect at least one error condition and a monitoring device coupled to the field asset. The monitoring device preferably includes a processor, memory coupled to the processor, a communications interface coupled to the processor, the memory and the controller board as well as a wireless network interface coupled to the memory and the

processor. The communications interface of the monitoring device is preferably operable to communicate with the field asset as well as a wireless network. The system preferably further includes a network operations center coupled to the wireless network. The network operations center is preferably operable to receive alerts indicative of error conditions occurring on the field asset from the monitoring device. In addition, the network operations center is preferably operable to display at least one entry indicative of an error condition existing on the field asset via an Internet enabled remote device.

One technical advantage provided by the present invention is the ability to remotely evaluate field asset performance.

Another technical advantage provided by the present invention is the ability to manage an asset from a remote device such as a two-way pager, mobile phone, PDA (personal digital assistant), computer or similar device.

Yet another technical advantage provided by the present invention is the ability to decrease field asset downtime through the real-time notification of field asset maintenance needs.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the present embodiments and advantages thereof may be acquired by referring to the following description taken in conjunction with the accompanying drawings, in which like reference numbers indicate like features, and wherein:

FIGURE 1 is a schematic drawing illustrating a field asset management system according to teachings of the present invention;

FIGURE 2 is a schematic drawing with portions cut away illustrating one embodiment of a monitored field asset according to teachings of the present invention;

FIGURE 3 is a flow diagram illustrating a method for monitoring the occurrence of error conditions on a field asset according to teachings of the present invention;

FIGURE 4 is a flow diagram illustrating a method for updating a field asset status database according to teachings of the present invention;

FIGURE 5 is a flow diagram illustrating a method for displaying field asset status to an authorized user via an Internet enabled remote device according to teachings of the present invention; and

FIGURE 6 is a schematic drawing illustrating one embodiment of an Internet-based presentation of a field asset's detailed status according to teachings of the present invention.

DETAILED DESCRIPTION

Preferred embodiments of the present invention and its advantages are best understood by referring to FIGURES 1-7 of the drawings, like numerals being used for like and corresponding parts of the various drawings. Referring first to FIGURE 1, a schematic drawing illustrating a field asset management system incorporating teachings of the present invention is shown. System 100 of FIGURE 1 illustrates one way in which a plurality of field assets 105 may be monitored, managed or otherwise manipulated using Internet 110 and wireless network 115 technologies. Preferably facilitating communications between field assets 105 and one or more Internet-enabled devices attached to Internet 110 is network operations center (NOC) 120.

NOC 120 may include one or more server systems 125 as well as one or more storage devices 130 to provide access to information associated with field assets 105. NOC 120 may also employ communications server 135 to receive information from and transmit information to wireless network 115 as well as to receive information from and transmit information to Internet 110. One or more server systems 125 may be coupled to communications server 135 directly and/or through Internet 110.

As depicted in FIGURE 1, NOC 120 is preferably operable to receive and transmit communications or information via wireless network 115 and Internet 110. Information that may be communicated to NOC 120 may include, but is not limited to, alerts transmitted by monitoring device 140 coupled to field asset 105, one or more control instructions transmitted by a remote device

and other information. In addition, NOC 120 may transmit control signals or instructions to monitoring device 140 operable to initiate testing of field asset 105 or to otherwise manage and control field asset 105. NOC 120 may also be employed to transmit information regarding the status of field asset 105 to a remote device or other desired destination.

As mentioned above, field asset 105 preferably includes monitoring device 140. Monitoring device 140 preferably employs a wireless technology solution to communicate alerts indicative of error conditions existing on field asset 105 to NOC 120. Monitoring device 140 is preferably further operable to receive control instructions from NOC 120. Monitoring device 140 preferably employs wireless network 115 for communication with NOC 120.

In one embodiment of the present invention, monitoring device 140 may be designed to poll field asset 105 to determine whether an error condition is present on field asset 105. Alternatively, monitoring device 140 may be informed of error conditions on field asset 105 by technologies included in field asset 105 notifying monitoring device 140 of the presence of the error condition's occurrence. As will be described in greater detail below, monitoring device 140 may also include the ability to address specific error conditions that occur on field asset 105. For those error conditions monitoring device 140 is not operable to correct, monitoring device 140 is preferably configured to package the uncorrected error conditions into an alert to be transmitted to NOC 120 via wireless network 115.

To provide authorized users with remote access to field asset 105 status, NOC 120 preferably updates one or more database entries on storage device 130 upon receipt of an alert from monitoring device 140. By updating the entries associated with individual field assets 105, a user, preferably via Internet 110, may connect to NOC 120 and view the current status of each field asset 105.

A user may employ a variety of user interface devices to connect to NOC 120. For example, a user may access NOC 120 via Internet 110 using computer 145, personal digital assistant (PDA) 150, mobile phone 155, pager 160 or a similarly equipped device. Other user interfaces may be used and are considered within the scope of the present invention.

In one embodiment, monitoring device 140 may be a generally self-contained unit employed to retro-fit an existing field asset 105 to accomplish teachings of the present invention. Alternatively, monitoring device 140 may be designed such that existing technologies within field asset 105 are leveraged, i.e., by adding application and control software as well as wireless communications hardware. Other monitoring device 140 designs and configurations are contemplated and are to be considered within the scope of the present invention.

Referring now to FIGURE 2, a schematic drawing with portions cut away illustrating a field asset 105 employing one embodiment of a monitoring device 140 configured to leverage the existing technologies of field asset 105 is shown according to teachings of the present invention. In FIGURE 2, field asset 105 has been manufactured to include diagnostic module 205. Diagnostic

module 205 is generally employed by a service technician when physically located at field asset 105.

Diagnostic module 205 is preferably operable to identify a variety of error conditions that can occur on field asset 105. In response to the identification of an error condition, diagnostic module 205 preferably generates a visible signal, such as one or more illuminated LEDs (light emitting diode), a message on a LCD (liquid crystal display), etc. to indicate to a service technician the source of the error condition.

Diagnostic module 205 preferably includes controller board 210 and serial I/O (input/output) 215. Controller board 210 is generally configured to monitor a variety of aspects or characteristics of field asset 105. For example, if field asset 105 is an ice bagging machine, controller board 210 may be configured to monitor such aspects as vend quantities, amount of change remaining in the machine, amount of sales, operation of cooling hardware, icebox temperature, etc. and further configured to generate an indicator in the event of an error condition associated with one or more of the monitored aspects. Serial I/O 215 is typically incorporated into diagnostic module 205 to allow a technician servicing field asset 105 to connect a diagnostic tool thereto. The diagnostic tool is commonly employed to download the current status of field asset 105 for use by the servicing technician.

As illustrated in FIGURE 2, field asset 105 preferably includes monitoring device 140 contained therein. Monitoring device 140 of FIGURE 2 preferably includes central processing unit (CPU) 225, memory 230,

serial interface 235 and communications network interface 240. Monitoring device 140 of FIGURE 2 preferably leverages the capabilities and functionalities of diagnostic module 205 by being operable to communicate with diagnostic module 205 via serial I/O 215. One or more sensors 245 may also be incorporated into monitoring device 140 to allow monitoring device 140 to measure one or more characteristics of field asset 105 not monitored by diagnostic module 205.

In a preferred embodiment of the present invention, monitoring device 140 is capable of storing and executing its own software. In such an embodiment, a program of instructions may be programmed in memory 230 enabling monitoring device 140 to poll diagnostic module 205 at timed intervals, or on command, to determine whether any error conditions are present on field asset 105. For example, the software may be enabled to instruct controller board 210 to test the integrity of various hardware components of field asset 105, to notify NOC 120 or remote device 125 in the event of an error condition, to access measurements taken by sensors 245 as well as to monitor and control other characteristics associated with field asset 105. In addition, a program of instructions enabling monitoring device 140 to correct specified error conditions on field asset 105 may also be programmed into memory 230. For example, monitoring device 140 may be programmed to reset various aspects of field asset 105, change to a maintenance mode as well as perform corrective measures.

In addition, management software may also be included on monitoring device 140 that allows monitoring

device 140 to remotely manage field asset 105. For example, when a corrective sequence is initiated by a user from any of the aforementioned remote devices and subsequently transmitted to monitoring device 140 via NOC 120, such management software may be employed to interpret the corrective sequence and to direct controller board 210 of field asset 105 such that the operation desired by the corrective sequence is effected.

Preferably included in the remote management functionality of the present invention is the ability to update one or more programs, such as device drivers, of instructions on monitoring device 140. Accordingly, monitoring device 140 may also be operable to receive software updates via wireless network 115.

Serial interface 235 is preferably included in monitoring device 140 operably coupled to CPU 225 and memory 230. Serial interface 235 enables monitoring device 140 to monitor and control field asset 105 by enabling monitoring device 140 to communicate with controller board 210 via serial I/O 215 included in diagnostic module 205. Although a serial connection between monitoring device 140 and diagnostic module 205 is discussed herein, other communications technologies may be employed to effect the desired exchange of information. Examples of such communications technologies include, but are not limited to, RS-232, Universal Serial Bus (USB), IEEE 1394 or "Fire Wire," and Ethernet.

Wireless network interface 240, operably coupled to CPU 225 and memory 230, is also preferably included in the hardware configuration of monitoring device 140

depicted in FIGURE 2. Wireless network interface 240 is included in the hardware configuration of monitoring device 140 of FIGURE 2 to enable monitoring device 140 to communicate with NOC 120 via wireless network 115. Wireless network interface 240 may also allow monitoring device 140 to communicate with one or more devices connected to Internet 110 through NOC 120 using wireless network 115. Preferably, the remote device used is capable of both receiving information sent by NOC 120 and sending information to NOC 120 via Internet 110. In one embodiment, ReFLEX25 and ReFLEX50 by Motorola may be employed as a wireless technology solution.

As mentioned above, NOC 120 is preferably operable to manage and control field asset 105 through monitoring device 140. As such, NOC 120 may be configured with the communications software, database software, etc., necessary to effect such operation. To that end, NOC 120 is preferably operable to provide an Internet-based management application to be used to remotely interact with the field asset 105 via monitoring device 140. Such an Internet-based management application is preferably accessible via Internet 110 using computer 145, PDA 150, mobile phone 155, two-way pager 160, etc., and preferably supports such Internet-based protocols as HTTP, SSL and XML.

Functionality preferably included in the Internet-based management application might include access to a listing of alerts that have been resolved, alerts that have not been resolved, details regarding alerts on selected field assets 105, periodic reports on monitored characteristics of field asset 105, as well as other

field asset 105 variables. To the end of interactivity, the Internet-based management application is preferably further capable of remotely controlling computing component 110 via monitoring device 140. For example, a user may want to issue a maintenance command to field asset 105 in an attempt to resolve one of the alerts that has yet to be resolved. Similarly, a user may want to further investigate the source of an unresolved alert by issuing a command to monitoring device 140 that further interrogates field asset 105 in an effort to pinpoint the source of the error condition for the user. The Internet based management application may also allow a user to send software updates to monitoring device 140. More detail regarding Internet access to field asset 105 status and control will be discussed below in association with FIGURE 6.

FIGURE 3 is a flow diagram illustrating a method for monitoring the occurrence of error conditions on a field asset 105 according to teachings of the present invention. Accordingly, method 300 of FIGURE 3 is one embodiment of a program of instructions that may be incorporated into monitoring device 140.

Upon initiation at 305, method 300 preferably proceeds to 310 where the current status of field asset 105 is checked. If at 310 no error conditions are detected or reported, method 300 preferably proceeds to 315. At 315, method 300 preferably remains in a wait or idle state until the next time period expires before initiation of another field asset 105 status check is to begin at 310.

If at 310 one or more error conditions are detected or reported, method 300 preferably proceeds to 320. At 320, method 300 preferably determines whether the detected error condition may be corrected by software included on monitoring device 140 or field asset 105. If at 320 it is determined that the error condition cannot be corrected by monitoring device 140, method 300 preferably proceeds to 325. At 325, the error condition is preferably packaged into an alert message to be transmitted to NOC 120. The alert message may include such information as the priority of the error condition, field asset 105 identification information, the specific error condition, as well as other telemetry information.

Once the message has been formatted, packaged and otherwise prepared for transmission, method 300 preferably proceeds to 330 where the alert is transmitted to NOC 120 via wireless network 115. Upon transmission of the alert at 330, method 300 preferably proceeds to 315 to assume the wait state.

If at 320 it is determined that the error condition can be addressed and corrected by software included in memory 230 of monitoring device 140, method 300 preferably proceeds to 335. At 335, a sequence of instructions designed to correct the error condition may be executed by monitoring device 140. Upon execution of the appropriate sequence of instructions at 335, method 300 preferably proceeds to 340.

At 340, the effectiveness of the corrective sequence of instructions is determined. If the corrective sequence of instructions is determined to have been ineffective, i.e., the error condition is still present, method 300

preferably returns to 335 for either a repeat of the sequence of corrective instructions or selection of an alternate sequence of instructions. A limit may be implemented on the number of loops allowed to occur at 340 before method 300 is forced to proceed to step 325 where the error condition is packaged and subsequently transmitted to NOC 120. Once the error condition has been corrected or the number of attempts to solve the error condition have been exhausted, method 300 preferably proceeds to 315 to await the next field asset 105 status check.

As mentioned above, field asset 105 may be configured to provide monitoring device 140 with real-time notification upon detection of an error condition. In such an embodiment, method 300 may be altered to accommodate this error condition detection difference while maintaining the ability to accomplish teachings of the present invention.

Referring now to FIGURE 4, a flow diagram illustrating a method for updating a field asset status database incorporating teachings of the present invention is shown. Method 400 of FIGURE 4 is preferably running in an idle state at 405 on one or more servers 125 at NOC 120. Method 400 preferably remains at 405 until an incoming alert is indicated by communications server 135. Upon leaving idle state at 405, method 400 preferably proceeds to 410. At 410, method 400 may receive the alert transmitted from field asset 105.

At 410, the alert is preferably parsed, decoded, decompressed or otherwise prepared for use by NOC 120.

Once the alert has been prepared for use by NOC 120 at 410, method 400 preferably proceeds to 415.

At 415, one or more databases on storage devices 130 may be updated to reflect the new error condition on field asset 105. Depending upon the error condition and upon user preference settings, a user alert, such as an automatic page or other electronic message, may be generated in response to certain error conditions detected on field asset 105. For example, a user may wish to be immediately notified in the event of a complete failure of field asset 105. As will be discussed in greater detail below, database entries associated with error conditions detected on individual field assets 105 are used by NOC 120 to display to users accessing the status of field assets 105 via one or more Internet-enabled devices. Once method 400 has alerted a user where requested at 420, method 400 preferably proceeds to 405 where another alert message is awaited.

Referring now to FIGURE 5, a flow diagram illustrating a general method for presenting a web page containing field asset 105 error conditions to an authorized user, according to teachings of the present invention, is shown. Method 500 of FIGURE 5 preferably remains running on server 125 in an idle state at 505. Upon receiving a request from a user for access to field asset 105 status information, method 500 preferably proceeds to 510.

At 510, method 500 preferably authenticates the user's identity. Authentication of users may be performed using a variety of authentication techniques, i.e., requesting a username and password for comparison with

information stored on one or more storage devices 130, as well as by other methods used by Internet websites to authorize users.

Once the user has been authenticated at 510, a web page listing the authorized user's field assets 105 may be presented. As will be discussed in greater detail below, the user's field assets 105 may be formatted for display on an Internet-enabled remote device such as computer 145, PDA 150, mobile phone 155 or pager 160.

From the listing of the authorized user's field assets 105 displayed at 515, the user may select one or more field asset links to view the details associated with that particular field asset's 105 status at 520. Once the user is presented with the details regarding the error conditions detected at the selected field assets 105, the user has the option to initiate one or more control instructions to be transmitted to and/or executed at the field asset 105. Once a user has selected to transmit one or more control instructions from NOC 120 to field asset 105, the transmission and initiation of the corrective sequence is performed at 525.

Once the corrective sequence has been transmitted to the selected field asset 105, method 500 preferably proceeds to 530 where the effectiveness of the corrective sequence is evaluated. Upon the determination that the error condition has been corrected and no longer exists, method 500 preferably proceeds to 535. At 535, the database containing entries indicative of the status of the repaired field asset 105 is preferably updated to reflect the corrected error condition. Method 500 may then proceed to 505 where another user is awaited or to

515 for a redisplay of the user's field assets 105. If at 530 the error condition is determined to still exist, method 500 preferably proceeds to 520 where the user is again allowed to select a corrective sequence for transmission and execution by field asset 105.

FIGURE 6 is a schematic drawing illustrating one embodiment of a web page displaying a field asset's detailed status according to teachings of the present invention. Illustrated in web page 600 are a variety of characteristics and controls associated with field asset 105.

In frame 605 of web page 600, a listing of an authorized user's field asset 105 links is preferably displayed. From the field asset link listing in frame 605, an authorized user is capable of monitoring and controlling each of the enumerated field assets 105 contained therein. Upon selection of a specific field asset link, the user is preferably presented with frame 610.

Preferably included in the field asset 105 detail of frame 610 is field asset 105 identification information 615. Identification information 615 may include such information as the type of field asset 105, i.e., vending machine, ice bagging machine, etc., physical location of field asset 105 as well as other information. As indicated at 620 of web page 600, field asset 105 information such as serial number, make and model, may also be displayed to the user. At 625, current characteristics, such as operating temperature and inventory count, of field asset 105 may also be displayed in frame 610.

In order to enable a user to remotely manage and monitor field asset 105, a display similar to that available to a service technician at the field asset 105 location may also be provided in frame 610. Accordingly, LED display 630 is preferably included in frame 610. LED display 630 preferably simulates the LED display the technician would see if the technician were physically present at field asset 105. Similarly, mode indicator 635 and additional information display 640 are also preferably included in web page 600. Each field asset 105 characteristic that is monitored by monitoring device 140 or diagnostic module 205 is preferably made available to a user on web page 600.

As mentioned above, a variety of control instructions may be needed to correct error conditions on field asset 105. To effect remote correction of an error condition on field asset 105, control panel or control options display 645 is preferably included in web page 600. Control options display 645 preferably includes the control options typically available to a technician physically present at field asset 105. Additional control options may also be included in control options display 645 to provide the user with greater control over field asset 105.

Web page 600 also preferably enables a user to address a variety of error conditions that may arise at field asset 105. By interpreting LED display 630, mode indicator 635, etc., the user may evaluate and determine the current error condition on field asset 105. Once an error condition has been identified and determined to be remotely addressable, the user may then select one or

more control options from control options display 645 to correct the current error condition. The control options may be selected by a user from one of the aforementioned remote devices. Once a selection is made, NOC 120 transmits the instruction to monitoring device 140 as described above with reference to FIGURE 5. As described above, once an error condition has been corrected, web page 600 may be updated to reflect the corrected status of field asset 105.

Although the present invention has been described with respect to a specific preferred embodiment thereof, various changes and modifications may be suggested to one skilled in the art and it is intended that the present invention encompass such changes and modifications fall within the scope of the appended claims.